

[54] **COLLECTION AND RECYCLING APPARATUS FOR CROP PARTICLES IN A ROLL FORMING MACHINE**

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[58] Field of Search **56/341-343, 56/1, DIG. 2; 100/86, 87, 88, 72, DIG. 3-DIG. 9**

[56] **References Cited**

U.S. PATENT DOCUMENTS

731,955	6/1903	Root et al.	100/72
753,032	2/1904	Bankey	130/24
3,036,515	5/1962	Nolt	100/72 X
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3,815,345	6/1974	Mast et al.	56/341
3,866,531	2/1975	Todd et al.	100/88

FOREIGN PATENT DOCUMENTS

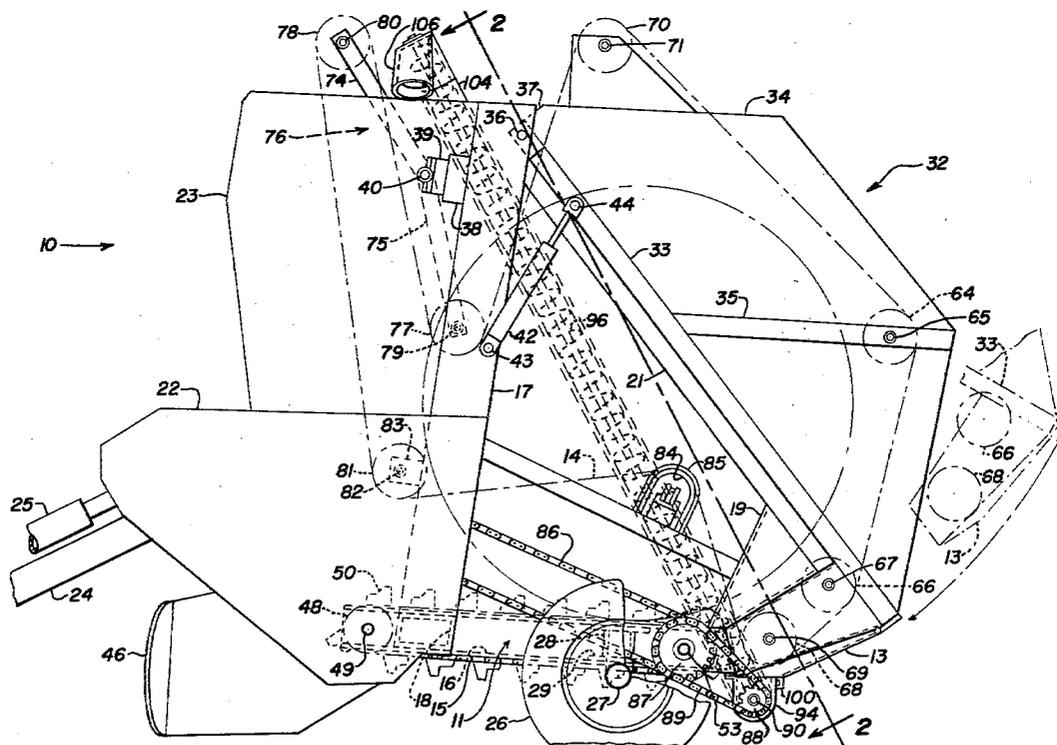
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[57] **ABSTRACT**

Apparatus in a crop roll forming machine for collecting particles of crop material lost from either the crop package or loose crop material during the roll formation process consisting of a collection pan, a horizontal collecting auger, an elevated delivery auger, intermeshing bevel gears, drive means and a discharge chute. The particles are recycled from the collection pan back into the roll forming region by the cooperative interaction of the horizontal collecting auger and the elevated delivery auger so that the crop material particles are directed out of the discharge chute and downwardly into the forwardmost portion of the bale forming region where the upper bale forming means works to include the particles in the crop roll being formed.

7 Claims, 2 Drawing Figures



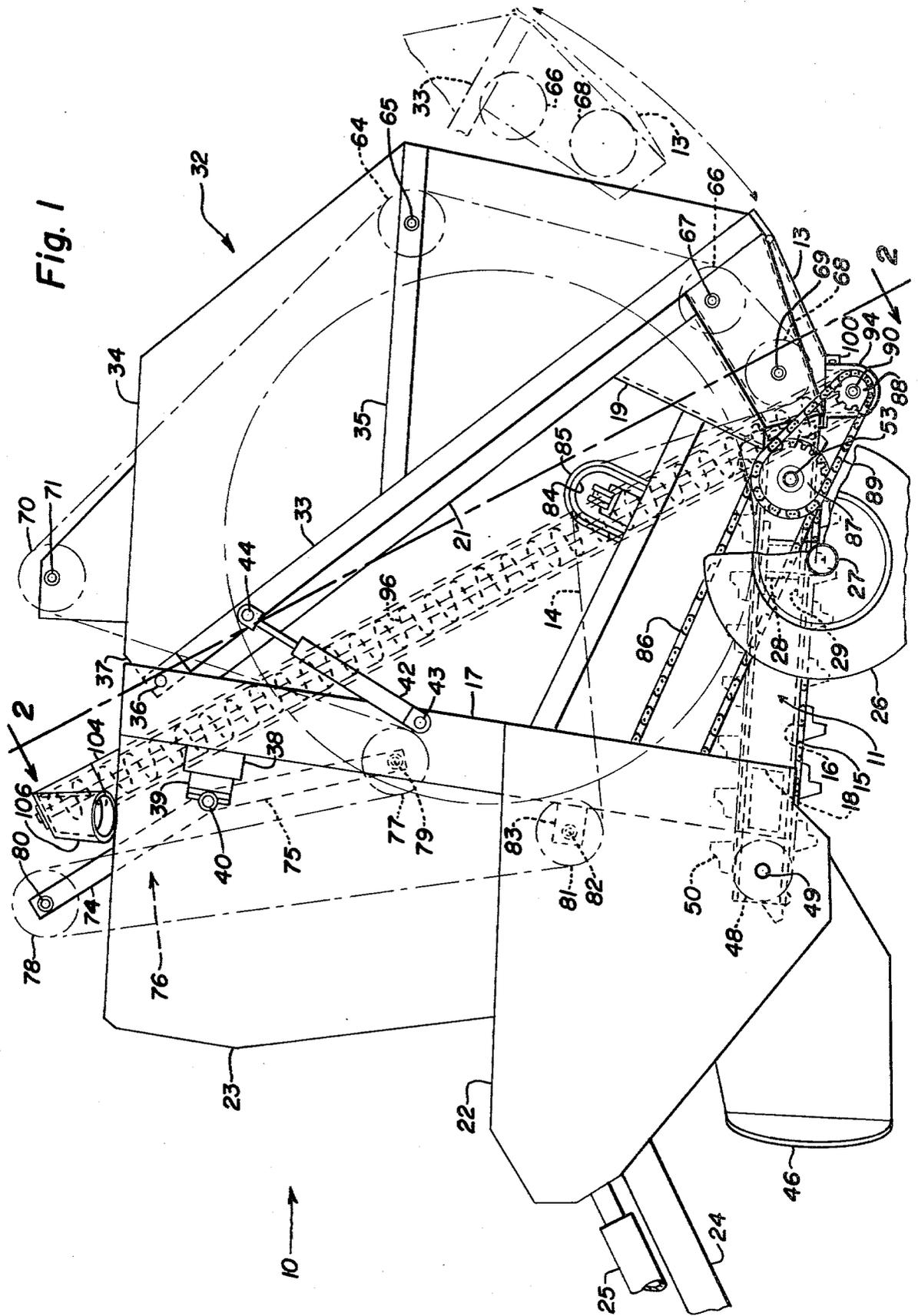
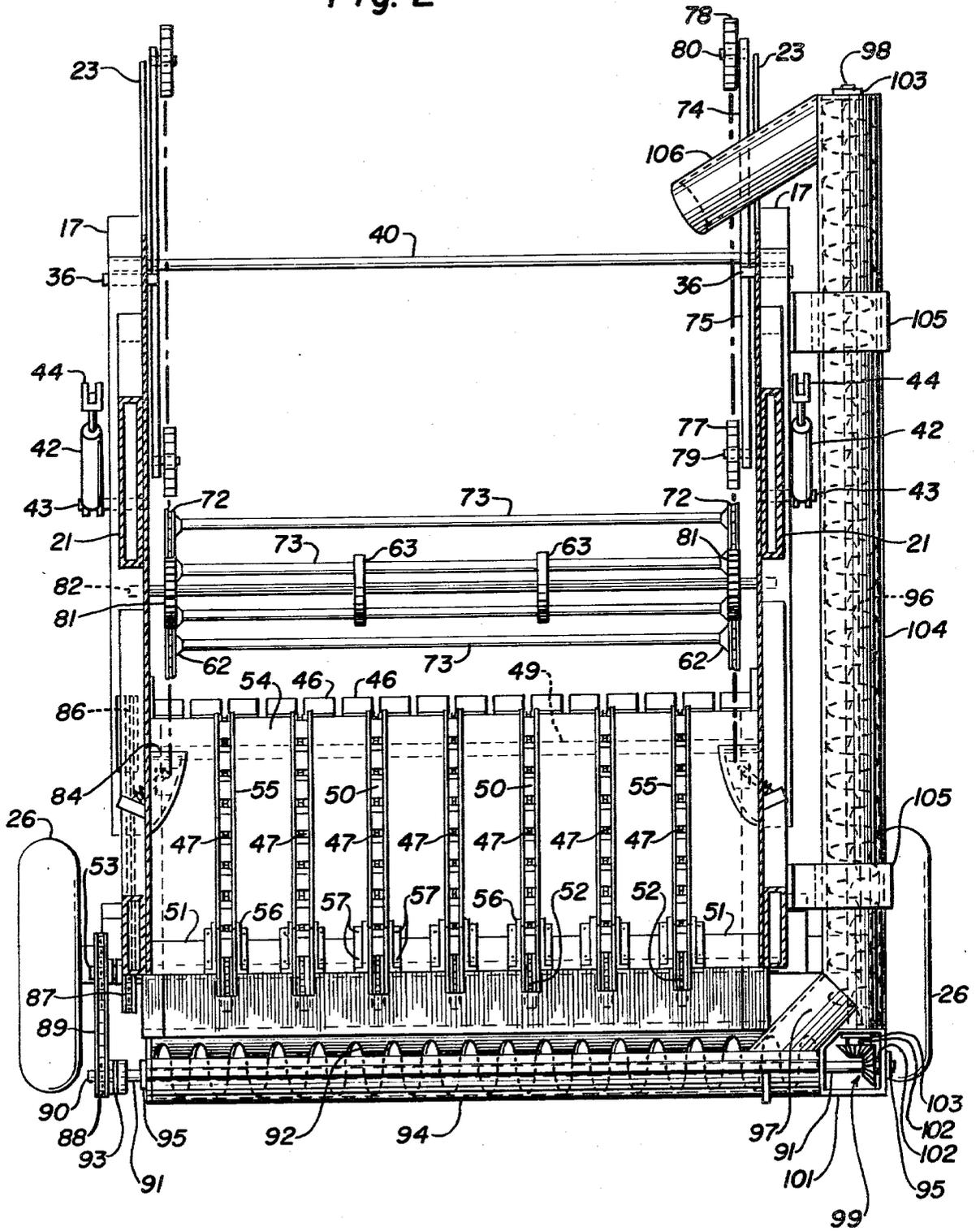


Fig. 1

Fig. 2



COLLECTION AND RECYCLING APPARATUS FOR CROP PARTICLES IN A ROLL FORMING MACHINE

BACKGROUND OF THE INVENTION

This invention is concerned primarily with crop roll forming machines. Specifically it is concerned with apparatus which collect crop material particles lost from the crop package or loose crop material during the roll formation process and recycle those particles back into the roll forming region for inclusion within the completed roll package.

Historically, it has been the custom to harvest forage crops by mowing the crops, letting them dry in the field, forming the dried crop material into windrows and passing a hay baling machine over and along those windrows to form the crop material into rectangular bales. Recent practice has shown that the formation of crop materials into large compact rolls, rather than rectangular bales as formerly done, permitted the crop material to be deposited in roll form and left in fields for extended periods of time since the rolled material tends to provide a self-shedding protective covering from inclement weather. The ability to leave these rolled bales in fields thus obviated the additional steps of gathering the rectangular bales and transporting them to a storage area protected from the elements.

Several methods for forming compact rolls of crop material have evolved through the years. In one of these methods, a machine rolls a swath or windrow of crop material along the ground until a roll of desired size is obtained. Examples of machines utilizing this principle are shown in prior U.S. Pat. No. 3,110,145, dated Nov. 12, 1963. Another similar machine comprises the subject matter of prior U.S. Pat. No. 3,650,100, dated Mar. 21, 1972. One of the principle difficulties in using this method of forming rolls of crop material is that a certain amount of the material remains upon the ground without being included in the roll. Furthermore, dirt, clods of earth, stones and the like can also be picked up by the roll and included therein. This is undesirable under certain circumstances.

A later, and more successful, method of forming crop rolls comprises a machine in which a swath or windrow of material is picked up from the field and directed onto a lower conveyor. This conveyor transports the material to a roll forming region where an upper apron or flight of belts, usually positioned above and adjacent the conveyor, moves in a suitable direction to rotate the crop material with which it contacts. The loss of crop particles from this type of machine has been a lingering concern. Variations of this type of crop roll forming machine are illustrated in U.S. Pat. No. 3,859,909 to Mast, dated Jan. 14, 1975, and U.S. Pat. No. 3,722,197, dated Mar. 27, 1973. An improvement of the former type of machine as shown in prior U.S. Pat. No. 3,866,531 to Todd, dated Feb. 18, 1975, attempted to solve this problem through the use of leaf springs.

The increasing popularity of crop roll forming machines has seen their use broaden from rolling wintering forage for livestock to rolling high protein crops, such as alfalfa, for dairy livestock where the amount of crop material loss is critical. In this latter area especially, interest in the amount of high nutrient crop material lost during roll formation has intensified.

The roll forming machines of the type taught in Todd with leaf springs have proven extremely effective in

virtually all types of crops. However, regardless of the type of crop, some crop particles were always lost from the crop material package as it was being rotated. Other particles would be carried out the back of the machine by the lower conveyor or lower apron. Since there was no collection apparatus, these particles merely fell back onto the field and were lost.

The foregoing problem is solved in the design of the machine comprising the present invention by substantially decreasing the amount of crop material lost during the roll formation process.

SUMMARY OF THE INVENTION

It is the principle object of the present invention to provide an improved crop roll forming machine that will collect any type of crop material particles lost from the crop package or loose crop material during the roll formation process and recycle those particles back into the roll forming region for inclusion in the completed roll package.

It is another object of the present invention to provide an improved crop roll forming machine that will be able to operate in high protein brittle crops with minimum crop loss and still utilize a mechanically simple and reliable crop recycling system.

These and other objects and advantages are obtained by providing apparatus in a crop roll forming machine for collecting particles of crop material lost from either the crop package or loose crop material during the roll formation process comprising a collection pan, a horizontal collecting auger, an elevated delivery auger, intermeshing bevel gears, drive means and a discharge chute. The particles are recycled from the collection pan back into the roll forming region by the cooperative interaction of the horizontal collecting auger and the elevated delivery auger so that the crop material particles are directed out of the discharge chute and downwardly into the forwardmost portion of the bale forming region where the upper bale forming means works to include the particles in the crop roll being formed.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages of this invention will become apparent upon consideration of the following detailed disclosure of the invention, especially when it is taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a partially diagrammatic side elevation of a roll forming machine illustrating the functional relationships of the intermeshing horizontal collecting and the elevated delivery augers, the collection pan, the discharge chute and the auger drive means.

FIG. 2 is a sectional view of the augers, the lower apron and the floor in a roll forming machine taken along the section line 2-2 of FIG. 1.

DETAILED DESCRIPTION

Briefly, FIG. 1 depicts a general representation of the roll forming machine 10 with a cutaway of the elevated auger 96, the bale forming means comprising the upper apron 14, and the conveying means comprising the lower apron 15. Machine 10 comprises a base frame 11 which has similar side arrangements of structural members fixedly connected together, such as by welding. Each side of the frame comprises a bottom horizontal member 16, with the forward end of the frame connected to a vertical member 17 of substantial height. Extending perpendicularly to the junction of

members 16 and 17 is a cross member 18, the adjacent end of which is fixedly connected to the junction of member 16 to 17. A short member 19 extends upwardly from the rear portion of horizontal member 16, the upper end of this member being connected to one end of an upwardly and forwardly extending angular brace member 21. This angular brace member 21 is connected at its upper end to the upper portion of vertical member 17. Extending forwardly from the front face of member 17, but not shown, at each side of the machine is an A-frame consisting of angularly related members. These angular members are also not shown, being masked behind the side shield 22. Apron shields 23 are affixed to vertical member 17 above shield 22. Extending forwardly from this A-frame is a tractor hitch 24. Aligned along the same axis but above hitch 24 is drive shaft 25 attached at its forward end to a tractor power takeoff. The various frame members thusly described comprise the base frame 11, the towing hitch and drive shaft. They may be formed from heavy structural tubing, channels, or any other appropriate structural form commonly employed in framing of the type described.

The forward end of the machine in FIG. 1 has an appropriate gearbox, not shown, connected to suitable transverse supporting means and the angular members of the A-frame. The gearbox is driven by shaft 25 which is the primary source of operational power for the machine. A power output shaft (not shown) extends from the gearbox to one side of the machine as viewed in FIG. 1 to transfer power from the gearbox through a system of belted sheaves and drive sprockets to the operational elements. Lower apron drive chain 86 transfers power from a sprocket (not shown) mounted on the gearbox power output shaft (not shown) to the lower apron drive sprocket 87 of FIG. 2. The power is then transferred through shaft 53 to the lower apron driven sprockets 52, also mounted about shaft 53. Sprockets 52 then transfer the power to drive the flexible lower apron chains 47. Shaft 53, as shown in FIG. 1, has mounted at one of its extremities sprocket 87, which is connected to horizontal auger sprocket 88 by the horizontal auger drive chain 89. Auger sprocket 88 is mounted about stub shaft 90. As best seen in FIG. 2, shaft 91 spans the width of the roll forming machine 10 and has the horizontal auger flighting 92 affixed to substantially its entire length. Shaft 91 has mounted interiorly of horizontal auger sprocket 88 a slip clutch 93 which selectively journals stub shaft 90 and shaft 91. The horizontal auger flighting 92 is contained within collecting trough 94, which is located at the rear of and slightly below floor 54 adjacent to angled cover plate 51. Horizontal auger journals 95 are placed on shaft 91 outside the end walls of collecting trough 94. Collecting trough 94 is reinforced by cross brace 100, best seen in FIG. 1, by welding, bolting or the like.

Collecting trough 94 is connected to elevated auger housing 104 by transition chute 97 as seen in FIG. 2. Horizontal auger shaft 91 is connected to elevated auger shaft 98 by a pair of intermeshing bevel gears 99. The bevel gears 99 are contained in gear housing box 101. The gears 99 have spacing washers 102 mounted on each of their shafts. Elevated auger shaft 98 has a journal 103 at each of its extremities. Elevated auger shaft 98 and elevated auger flighting 96 are contained within elevated auger housing 104. Housing 104 is securely mounted to the roll forming machine 10 by mounting brackets 105. Discharge chute 106 is attached to the upper end of elevated auger housing 104 in any suitable

fashion, such as welding, and at such an angle as to permit the crop particles recycled from the collecting trough 94 to be discharged back into the forwardmost portion of the roll forming region between the upper apron 14 and the lower apron 15.

An upper frame 32 is provided with side frames composed of straight frame members 33, the ends of which are connected to the opposite ends of an encasing frame member 34. A horizontal upper frame member 35 is fixedly fastened to frame member 33 and encasing frame member 34 at its opposing ends. The uppermost portion of each side frame member is pivotally connected at 36 to a suitable bearing fixed to the upper end of vertical frame member 17. Frame member 37 extends between the upper ends of straight frame member 33, thereby stabilizing the connection to the base frame 11 of the upper frame 32 at pivotal connections 36. The upper end of base frame 11 is further stabilized transversely by a bracing member 38 which extends between bearing brackets 39 which are connected to the front faces of the vertical frame members 17.

Upper frame 32 is moved from its lower, bale forming position as shown in FIG. 1 to its extended bale discharge position, not shown, by a pair of hydraulic cylinders 42. These hydraulic cylinders have their barrel ends 43 connected to vertical members 17 and their rod ends 44 connected to members 33 of upper frame 32. Suitable hydraulic lines, not shown are connected to opposite ends of cylinders 42 to simultaneously activate and control the operation of the upper frame.

The base frame 11 has a pair of wheels 26 connected thereto on opposite sides of the frame by an axle 27, reinforced by transverse beam 28 and support plates 29, to permit the roll forming machine to be drawn by a tractor or other suitable implement over a field for the purpose of forming rolls of crop material.

Extending forwardly from the front end of the base frame 11 is a pickup header 46, still referring to FIG. 1. This header is adapted to engage, elevate and rearwardly feed a swath or windrow of crop material onto the roll forming machine. The material engaged by the header passes rearwardly from the entrance end of lower apron 15 towards the rear of the machine. The lower apron 15 comprises a conveying means having a series of endless, flexible chains 47, see briefly FIG. 2, which are uniformly spaced transversely across the plane generally defined by the floor 54 of the roll forming machine. These endless, flexible chains 47 extend around driven sprockets 48 rotatably mounted on shaft 49 at the forward end of roll forming machine. The chains 47 also pass around lower apron driven sprockets 52 rotatably mounted at the rear of the machine about shaft 53. Mounted above the horizontal member 16 of base frame 11 is the floor 54, shown primarily in FIG. 2. Mounted to the floor by bolts (not shown) partially encasing sprockets 52 is an angled cover plate 51 through which the chains 47 pass as they travel around sprockets 52. An angled bottom plate (not shown) is fastened to the bottom of horizontal member 16 in any suitable fashion, such as welding or bolting, to completely enclose the rear floor area. The floor 54 is rigidly connected to frame 11 by a series of extending bars (not shown), the opposite ends of which are suitably connected to horizontal member 16 of base frame 11 to support the floor in a generally horizontal position. The upper courses of chains 47 slide in channels 55 on floor 54, as shown in FIG. 2. These channels are transversely spaced apart and suitably secured to floor 54 to support

and guide the chains across the floor of the machine. The links of chains 47 have lugs 50 connected thereto. Adjacent each side of these channels 55 is a chain strip-
per plate 56 mounted to the angled cover plate 51 by
adjustable fasteners 57 at the plate's front and rear ends. The upper courses of the chains 47 move in a direction
toward the rear of the roll forming machine, so that the
lugs 50 engage and direct crop material rearwardly
across the floor portion of the machine.

The rear end of floor 54 abuts tailgate 13 when the
tailgate is in the closed, bale forming position, as shown
in FIG. 1. The phantom depiction of tailgate 13 parti-
ally illustrates the path of the tailgate 13 as the upper
frame 32 is raised to the bale ejecting position. An ad-
justable plate (not shown) can be affixed to either the
bottom portion of tailgate 13 or to the lowest portion of
angled cover plate 51 to redress any inconsequential
misalignments caused by manufacturing imprecisions to
permit contiguous engagement of the lower tailgate and
cover plate 51 when the tailgate is in the closed, bale
forming position.

The upper apron 14 preferably comprises a pair of
endless flexible link type chains 72 having, at longitu-
dinally spaced intervals, bars 73 which extend between
these chains the full width of the machine. The bars 73
may be square or of any other suitable geometric shape.
These bars 73 are fastened by bolts (not shown) to the
individual links of chain 72 of upper apron 14 by mount-
ing brackets 62 as shown in FIG. 2.

The upper apron 14, as shown in FIG. 1, is supported
and driven by various rollers and sprockets at each side
of the upper frame 32. Guide rollers 64 and 66 are
mounted about shafts 65 and 67 on opposing sides of the
middle and lower portions of upper frame 32. Guide
sprockets 68 and 70, respectively, are supported by
clevises (not shown) which are connected to the oppo-
site ends of the encasing frame member 34. Sprockets 68
and 70 are mounted about shafts 69 and 71 respectively.
Extending from the ends of shaft 40, which is supported
in bearing brackets 39 adjacent the upper end of vertical
frame member 17, are two pair of parallel arms 74 and
75. These arms comprise the expansion means 76 for the
upper apron 14. The ends of these arms support rotat-
able guide sprockets 77 and 78 upon which the endless
chains of upper apron 14 extend in the manner shown in
FIG. 1. Sprockets 77 and 78, respectively are mounted
about shafts 79 and 80. A tensioning means, not shown,
operates to maintain the upper apron in contact with the
roll of crop material as it is being formed so that a par-
ticular density of material can be obtained. Driving
sprockets 81 are provided at each side of the base frame
and are connected to a driven shaft 82 that is supported
in bearing brackets 83 fixed relative to the base frame
11. Mounted intermediately about shaft 82 is a pair of
spaced guide rollers 63, best shown in FIG. 2. Each side
of the lower course of the upper apron 14 also slidably
extends over the upper curved surface of retractably
mounted auxiliary guide members 84, of the type de-
scribed in detail in prior U.S. Pat. No. 3,815,345 dated
June 11, 1974, to Mast. These auxiliary guide members
84 are spring loaded and are adapted to be retracted into
accommodating spaces in the side plates of the machine
so as not to interfere with the ends of the roll of material
as the roll is being formed. Therefore, as the roll in-
creases in diameter the auxiliary guide plates 84 will be
pushed through openings 85 so as not to interfere with
the ends of the roll as the roll increases in diameter.

In operation, as the roll forming machine is drawn
over a field its pickup header 46 retrieves a swath or
windrow of crop material from the field, elevating and
transporting this material onto the floor 54 of the roll
forming machine. This material is placed on the floor
where the lugs 50 mounted on the flexible chains 47
transport the material from the front portion of the floor
towards the rear. Thus, a continuous stream of crop
material is delivered to the floor of the machine and
then is directed to the rearmost portion of this floor
where it contacts the upper apron 14. The upper apron
is rotating in a suitable direction, in combination with
the direction of rotation of the lower apron chains 47, to
cause the crop material to be rotated so as to form the
material into a roll. The tailgate 13 permits the guide
sprockets 68 to be positioned close to the ground and,
hence, the crop material to be easily started in rotative
motion.

This procedure is continued, progressively increasing
the diameter of the roll of material. During this roll
forming cycle particles of crop material are lost either
as the rolled crop material package is being formed or
from the loose crop material being transported by the
lower apron. The vast majority of these crop particles
are lost at the rear of the cover plate 51. Prior roll form-
ing machines permitted some of these lost crop particles
to escape through the slit formed by the junction of the
rear end of the cover plate 51 and the bottom portion of
the upper frame 32. Concurrently these crop particles
would accumulate in the bottom of upper frame 32 until
the crop roll was full sized and ready for ejection from
the machine. At such times the upper frame 32 would be
raised by the hydraulic cylinders 42 to allow the roll of
crop material to be discharged from the rear of the
machine. However, raising upper frame 32 would also
cause the lost crop particles to be dumped from the
upper frame onto the ground. The machine in the pres-
ent invention directs these lost particles into a collecting
trough 94 formed at the rear of the floor 54 and actively
returns them to the bale forming region formed between
the upper and lower aprons by the cooperative func-
tioning of the horizontal and elevated auger flightings
92 and 96 respectively. This is effected by the collection
and transfer of these crop particles by the horizontal
auger 92 through the transition chute 97 to the elevated
auger 96. The elevated auger 96 then delivers the parti-
cles upwardly to the discharge chute 106 where they
are directed downwardly into the forwardmost portion
of the bale forming region. There the upper apron 14
works to include the particles in the crop roll being
formed. Slip clutch 93 permits the horizontal auger
sprocket 88 to turn freely should either of the horizontal
or the vertical auger flightings, 92 and 96 respectively,
become jammed by an obstruction during operation.

When the roll of crop material is finally formed and it
is desired to discharge the formed roll from the ma-
chine, upper frame 32 is elevated through the use of
hydraulic cylinders 42 and the lugs 50 mounted on the
chains 47 of the lower apron positively engage the bot-
tom-most portion of the rolled crop material. This
causes the roll of material to be moved rearwardly until
it is urged off the roll forming machine. Once the bale
has cleared the machine the upper frame 32 is lowered
into the bale forming position, shown in FIG. 1.

While the preferred structure in which the principles
of the present invention have been incorporated is
shown and described above, it is to be understood that
the invention is not to be limited to the particular details

thus presented, but, in fact, widely different means may be employed in the practice of the broader aspects of this invention. The scope of the appended claims is intended to encompass all obvious changes in the details, materials and arrangement of parts which will occur to one of skill in the art upon a reading of this disclosure.

Having thus described the invention, what is claimed is:

- 1. A roll forming machine for crop material comprising:
 - (a) a mobile frame adapted to move across an open field, said frame having a front end, two opposing sides, and a rear end;
 - (b) conveying means fixed to said frame, said conveying means having a front end, two opposing sides and a rear end thereby defining a transport plane along which crop material is moved from said front end towards said rear end, said front end, opposing sides and rear end of said conveying means further being in substantially the same orientation as said front end, opposing sides and rear end of said frame;
 - (c) pickup means mounted to said frame adjacent said front end of said conveying means for engaging crop material and depositing it on said transport plane of said conveying means;
 - (d) bale forming means mounted to said frame substantially above said conveying means defining therebetween a bale forming region, said bale forming means including a movable motion-imparting curvilinear surface extending at least from a first location substantially in the same plane as said transport plane to a second location above said transport plane;
 - (e) drive means operably connected to said bale forming means to impart motion thereto such that crop material delivered to the bale forming region by said conveying means is rotated to form a substantially cylindrical bale;
 - (f) collection means supported on said frame adjacent said conveying means' rear end, said collection means positioned below said transport plane and at least partially below said first location of said bale forming means; and
 - (g) return means supported on said frame whereby crop material accumulated by said collection

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means is moved therefrom back to the bale forming region.

2. The roll forming machine according to claim 1 wherein said collection means further comprises an elongate, open-topped, trough-like pan extending substantially between said two opposing sides of said frame.

3. The roll forming machine according to claim 2 wherein said return means further comprises a horizontal auger conveyor substantially extending the length of said collection pan and contained substantially therein, an elevated auger operably connected to said horizontal auger, drive means drivingly connected to said horizontal and elevated augers, and an auger housing encasing at least said elevated auger, said elevated auger extending from said horizontal auger to an elevated position at least above and at the front portion of said bale forming region, said auger housing further connecting said collection pan with said elevated position and having thereat an opening into said bale forming region thereby forming a path of flow for crop material such that crop material falling into said collection pan is delivered by said horizontal auger to said elevated auger and then returned to said bale forming region.

4. The roll forming machine according to claim 1 wherein said bale forming means further comprises an endless upper apron made of endless flexible chains interconnected by a plurality of cross members, said cross members embodying substantially rigid bars uniformly spaced apart and fastened to said flexible chains, said chains further extending from said first location at least substantially in the same plane as said transport plane upwardly toward said second location, being selectively supported therebetween on retractable cams.

5. The roll forming machine according to claim 1 wherein said bale forming means further comprises an endless flexible belt movably supported on a plurality of rollers mounted to said frame.

6. The roll forming machine according to claim 1 wherein said bale forming means further comprises a plurality of endless side-by-side flexible belts movably supported by a plurality of rollers mounted on said frame.

7. The roll forming machine according to claim 1 wherein said bale forming means further comprises a plurality of rotatable motion-imparting cylinders supported between said opposite sides of said frame.

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